



INDIANA DEPARTMENT OF TRANSPORTATION Division of Materials and Tests

Directive 305

Hot Mix Asphalt Mix Design Laboratory Requirements

This guidance applies to all **qualified** HMA mix design laboratories that design HMA mixtures for INDOT contracts. These procedures supersede all previous guidance. Section references are for the most recent Standard Specifications. Contract documents will have precedence over this guidance.

APPROVAL

The requirements to become and maintain status as a **Qualified** HMA Mix Design Laboratory include the following:

1. Participation in the AASHTO re:source on-site laboratory assessments for:

Aggregate Equipment

Aggregate Demonstration Tests for:

AASHTO T 11 --	Materials Finer than 75µm Sieve in Mineral Aggregates by Washing
AASHTO T 84 --	Specific Gravity and Absorption of Fine Aggregate
AASHTO T 85 --	Specific Gravity and Absorption of Coarse Aggregate
AASHTO T 304 --	Uncompacted Void Content of Fine Aggregate
ASTM D4791 --	Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

Asphalt Equipment

Asphalt Demonstration Tests for:

AASHTO T 30 --	Mechanical Analysis of Extracted Aggregate
AASHTO T 166 --	Bulk Specific Gravity of Compacted Bituminous Mixtures
AASHTO T 209 --	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
AASHTO T 269 --	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
AASHTO T 283 --	Resistance of Compacted Bituminous Mixture to Moisture Induced Damage
AASHTO T 312 --	Method for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the SHRP Gyratory Compactor
AASHTO T 331 --	Bulk Specific Gravity and Density of Compacted Asphalt Mixtures using Automatic Vacuum Sealing Method

At least one of the following:

- AASHTO T 164 -- Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt
- AASHTO T 308 -- Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method
- ASTM D8159 -- Automated Extraction of Asphalt Binder from Asphalt Mixtures**

2. Submittal of the AASHTO re:source laboratory assessment with comments addressing all footnotes (special emphasis on comments, especially repeat write-ups)
3. Participation in the AASHTO re:source Proficiency Sampling Program for HMA Ignition Oven or Extraction (T 308 or T 164/D8159), HMA Design Gyratory samples, Fine Aggregate (T 11, T 27, T 84, T 304), and Course Aggregate (T 11, T 27, T 85).
4. Submittal of the AASHTO re:source proficiency sample results with comments addressing all ratings of two or less

DESIGN MIX FORMULA

The Design Mix Formula (DMF) shall represent the mix design, loose mixture, and compacted specimens prepared by the mix design laboratory. The materials used in the mix design shall be from a **qualified** or certified source and be **qualified** materials from that source, if applicable. Fines added to the mixture during the design to account for breakdown of material during production shall be included in the DMF and blended aggregate forms.

MIX DESIGN METHOD -- DENSE GRADED MIXTURE

HMA dense graded mixture shall be designed in accordance with AASHTO R 35. This practice requires the air voids to be plotted against the binder content to develop a curve from which the optimum binder content at N_{des} may be determined. A mix design with an irregular plot or poorly conforming data may not be **accepted**. The following are requirements for dense graded mixtures:

1. The compaction temperature for the specimens shall be $300 \pm 9^{\circ}\text{F}$ ($150 \pm 5^{\circ}\text{C}$).
2. The optimum binder content shall produce 5.0% air voids at N_{des} .
3. The design shall have at least four points, including a minimum of two points above and one point below the optimum.

HMA 4.75 mm mixture shall have the following additional requirements:

1. The optimum binder content shall produce 5.0% air voids at N_{des} .
2. Coarse aggregate angularity requirements do not apply.
3. Flat and elongated requirements do not apply.

QC/QA HMA and HMA may be produced by using a water-injection foaming device for all ESAL categories and mixture types.

The design gradation shall be less than or equal to 58.0% passing the 2.36mm sieve for all 9.5 surface mixtures.

The percent draindown shall not exceed 0.30 % in accordance with AASHTO T 305. A smaller size mesh at the bottom of the basket may be needed for 9.5mm mixtures.

MIX DESIGN METHOD -- OPEN GRADED MIXTURE

HMA open graded mixture shall be designed in accordance with AASHTO R 35, with the following exceptions:

1. The optimum binder content shall produce 15.0% - 20.0% air voids for 19.0 mm and 25.0 mm open graded mixtures (target is 17.5%).
2. The optimum binder content shall produce 12.0 – 17.0% air voids for 9.5 mm open graded mixtures (target is 14.5%).
3. A one point design may be used.
4. The compaction temperature shall be 260° F (125°C).
5. The bulk specific gravity of open graded specimens shall be determined in accordance with AASHTO T 331.
6. The moisture susceptibility requirements of AASHTO T 283 do not apply.
7. Fine aggregate angularity determination does not apply
8. The percent draindown shall not exceed 0.30 % as determined in accordance with AASHTO T 305.
9. Fibers may be incorporated into the mixture.

The binder for open graded mixtures containing fibers may be reduced by one temperature classification, 6°C, for the upper temperature classification. The fiber type and minimum dosage rate shall be in accordance with AASHTO M 325.

The binder for open graded mixtures containing recycled asphalt shingles may be reduced by one temperature classification, 6°C, for the upper temperature classification if 3% by mass of mixture are used.

MIX DESIGN METHOD -- SMA MIXTURE

SMA mixture shall be designed in accordance with AASHTO M 325 and R 46. The SMA mix design shall include the aggregate gradation as a percent passing by mass. The percent passing by mass is used as the means for acceptance of mixture. The following requirements also apply to SMA mix designs:

1. The optimum binder content shall produce 4.0 % air voids.
2. Steel furnace slag or sandstone coarse aggregate may be used, as well as crushed dolomite, crushed gravel, and polish resistant aggregates when blended with steel furnace slag or sandstone. The coarse aggregate is required to be class AS in accordance with Section 904.03(a).
3. Suitability of an aggregate blend for use in SMA shall be determined by ITM 220.
4. The fine aggregate shall be limestone, dolomite, crushed gravel, steel furnace slag, or air-cooled blast furnace slag.

5. The fine aggregate portion of the aggregate blend shall be non-plastic as determined in accordance with AASHTO T 90.
6. Mineral filler shall consist of dust produced by stone, portland cement, or other inert mineral matter having similar characteristics. The material shall be in accordance with the gradation requirements of Section 904.02(h) for size No. 16 and the quality requirements of ITM 203 or be from an air-cooled blast furnace slag source. The sieve analysis shall be conducted in accordance with AASHTO T 37 except as noted in Section 904.06. The material shall be non-plastic in accordance with AASHTO T 90.
7. The percent draindown shall not exceed 0.30 % in accordance with AASHTO T 305.

CONDITIONING LABORATORY PRODUCED MIXTURE

The mix design procedure requires mixtures to be conditioned for 4 hours in accordance with AASHTO R 30 prior to compaction of the mixture to N_{des} gyrations. Mixture conditioning is required in a force-draft oven for $4\text{ h} \pm 5\text{ minutes}$ at a temperature of $300 \pm 5^{\circ}\text{F}$ ($150 \pm 3^{\circ}\text{C}$) for dense graded and SMA mixtures and $260 \pm 5^{\circ}\text{F}$ ($125 \pm 3^{\circ}\text{C}$) for open graded mixtures.

MOISTURE SUSCEPTIBILITY

The moisture susceptibility of HMA dense graded mixtures and SMA mixtures shall be determined in accordance with AASHTO T 283 except as follows:

1. The loose mixture shall be conditioned for 4 h in accordance with AASHTO R 30.
2. The specimens shall be compacted in accordance with AASHTO T 312.

If anti-stripping additives are added to the mixture, the dosage rate shall be submitted with the DMF.

PG BINDER GRADE AND SOURCE CHANGE

A PG binder grade or source change will not require a new mix design. If the upper temperature classification of the PG binder is lower than the original PG grade, a new TSR value is required. A new DMF shall be submitted for a binder grade change and shall reference the originating DMF number.

MAXIMUM SPECIFIC GRAVITY OF HMA

The maximum specific gravity of HMA mixture shall be mass determined in water in accordance with AASHTO T 209.

If the supplemental procedure for mixtures containing porous aggregates is required by AASHTO T 209, this procedure shall be designated on the DMF. This should not be requested unless there is at least one aggregate with an absorption of 1.50% or greater. If no individual aggregate has an absorption of 1.50% or greater, additional documentation shall be provided indicating why the supplemental procedure is requested.

GYRATORY COMPACTOR

The gyratory compactor is required to be of a make and model as shown on the **Qualified Products List of Superpave Gyratory Compactors**. The gyratory compactor is required to have the specimen molds tilted to an average internal angle of $1.16 \pm 0.02^\circ$ (20.2 ± 0.35 mrad). The compactor shall be verified at least once per year in accordance with AASHTO T 344. Gyratory compactors shall provide the specified number of gyrations without additional compaction that may occur from "squaring of the specimen" or other compaction.

COOLING OF GYRATORY COMPACTED SPECIMENS

The procedures contained in Directive 303 will be used by INDOT to cool dense graded, SMA, and open graded gyratory compacted specimens

BULK SPECIFIC GRAVITY OF COMPACTED DENSE GRADED HMA

The bulk specific gravity of compacted dense graded HMA shall be determined in accordance with AASHTO T 166 Method A. AASHTO T 331 shall be used when the percent of water absorption exceeds 2.0 %.

BULK SPECIFIC GRAVITY OF COMPACTED OPEN GRADED HMA

The bulk specific gravity of compacted open graded HMA shall be determined in accordance with AASHTO T 331.

BULK SPECIFIC GRAVITY OF AGGREGATES

The bulk specific gravity of aggregates to be used in all mix designs will be determined by INDOT and provided to the mix design labs. INDOT will determine the bulk specific gravity of fine aggregates by AASHTO T 84 and coarse aggregates by AASHTO T 85. A list of aggregate Gsb values along with instructions for use will be posted online annually, and addendums will be posted online as needed.

The bulk specific gravity of the combined aggregate blend with RAP shall be calculated in accordance with ITM 584.

INDOT will conduct aggregate bulk specific gravity testing on plant produced stockpiles at the request of the design lab. The request shall include T84, T85 and gradation data. If it is determined that published INDOT Gsb list is not representative of that specific stockpile, the Department determined stockpile Gsb value may be used on the DMF.

DUST/CALCULATED EFFECTIVE BINDER RATIO

The dust to calculated effective binder ratio shall be determined in accordance with AASHTO R 35. This value shall be 0.6 to 1.4 for dense graded mixtures and 1.0 to 2.0 for 4.75 mm mixtures (OG and SMA do not have dust/Pbe requirements).

SURFACE AGGREGATES

The coarse aggregate types used in HMA surface mixtures shall be in accordance with 904.03(d)1. The sources of Polish Resistant Aggregates are listed in the INDOT **Qualified Products** List.

Crushed stone or gravel that has been accepted for use by the procedures in ITM 221 may be used for ESALs greater than or equal to 3,000,000.

FINE AGGREGATE ANGULARITY

The fine aggregate angularity shall be determined in accordance with AASHTO T 304 and shall include that portion of the coarse aggregate, fine aggregate and RAP aggregate retained on the specified sieves. A procedure has been written on how to prepare a blended aggregate sample and determine the Gsb. The material shall be representative of the selected aggregate blend. Crushed gravel for SMA shall have a minimum fine aggregate angularity value of 45, but there is no FAA requirement for the total blended aggregate. Open graded mixtures do not require fine aggregate angularity determination.

COARSE AGGREGATE ANGULARITY

The coarse aggregate angularity shall be determined in accordance with ASTM D 5821 and shall include that portion of the coarse aggregate and RAP aggregate retained on the specified sieves. For SMA mixtures, the total blended aggregate shall be 100 % one face and 95 % two faced crushed. The material shall be representative of the selected aggregate blend. Coarse aggregate angularity of aggregates shall be determined based on mass.

FLAT AND ELONGATED PARTICLES

The flat and elongated particles shall be determined in accordance with ASTM D 4791 and shall include that portion of the coarse aggregate and RAP aggregate retained on the specified sieves. The material shall be representative of the selected aggregate blend. Flat and elongated particles shall be determined based on mass for each sieve size equal to or larger than 9.5 mm. The percent of flat and elongated particles on each required sieve shall be reported.

BINDER CONTENT BY IGNITION

The binder content by ignition shall be determined in accordance with ITM 586. At least four calibration samples and a calibration factor are required to be submitted for each DMF. A test temperature of 427 °C may be used for mixtures containing dolomite. The binder content shall be the value indicated on the computerized printout.

BINDER CONTENT BY EXTRACTION

The binder content by extraction shall be determined in accordance with ITM 571.

MIXTURE ADJUSTMENT FACTOR

The Mixture Adjustment Factor (MAF) reported on the DMF for dense graded and SMA mixtures is equal to the Gmm of the mix design divided by 2.465 for 9.5 mm mixtures or the Gmm of the mix design divided 2.500 for 12.5 mm, 19.0 mm, and 25.0 mm mixtures

If the MAF calculation results in a value of 0.980 to 1.020, then the MAF shall be considered to be 1.000. If the MAF is less than 0.980 or greater than 1.020, then the actual calculated MAF value shall have either 0.020 added or subtracted from the value.

The MAF does not apply to open graded mixtures.